



# Madrean Archipelago Rapid Ecoregional Assessment



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Together with partners, the Bureau of Land Management is conducting rapid ecoregional assessments covering much of the American West. These assessments look at large geographic regions and document key ecological resources, such as species and habitats, describe primary influences on these resources, characterize their status and trends, and provide tools and data to support future management and conservation decisions.

A primary aspect of these assessments is the identification of Conservation Elements (species and ecosystems) of particular significance within the ecoregion. Conceptual Models were developed for each of the Conservation Elements (CEs), characterizing their ecology and dynamics and describing their key ecological attributes. This brochure highlights the Apacherian-Chihuahuan Semi-Desert Grassland and Steppe ecological system CE, results of the status assessment and its bioclimate envelope.

## Introduction

This ecosystem is a broadly defined desert grassland and mixed shrub-succulent type that is typical of the Borderlands of Arizona, New Mexico and northern Mexico (Apacherian region). Its distribution extends west to the Sonoran Desert, north into the Mogollon Rim in central Arizona and east into Trans Pecos or West Texas and throughout much of the Chihuahuan Desert. The CE is abundant on foothills and adjacent alluvial fans that encircle mountain ranges and on middle elevation piedmonts and valleys.

The vegetation in this mixed semi-desert grassland ecosystem is characterized by a typically diverse layer of perennial grasses with scattered stem succulents and shrubs. Many grass species are found in it. Succulent species of *Agave*, *Dasyllirion*, *Nolina*, *Opuntia*, and *Yucca*, and short-shrub species of *Calliandra*, *Mimosa*, and *Parthenium* are scattered throughout. Various oaks (e.g. *Quercus grisea*, *Quercus emoryi*, *Quercus arizonica*, *Quercus*

## Apacherian-Chihuahuan Semi-Desert Grassland and Steppe Ecosystem

### Natural Dynamics

Historically, the Apacherian-Chihuahuan Semi-Desert Grassland and Steppe burned frequently; these grasslands were maintained as open grasslands with low shrub cover by fire return intervals of 2.5 to 10 years. Many stands have a shrub or stem succulent component (*Agave* and *Yucca* spp.) under natural conditions. This woody component increases in density over time in the absence of disturbance such as fire. Some stands with deep argillic soil horizons appear resistant to shrub and tree invasion without disturbance.

*oblongifolia*) may be present with low cover. These grasslands support many species of wildlife including pronghorn, desert box turtle and many birds; nectar-feeding bats forage on the *Agave* flowers. It is a key ecosystem type, which is why it was chosen as a conservation element for this Rapid Ecoregional Assessment.



Grasslands near Elgin, Az. Photo by T. Robertson

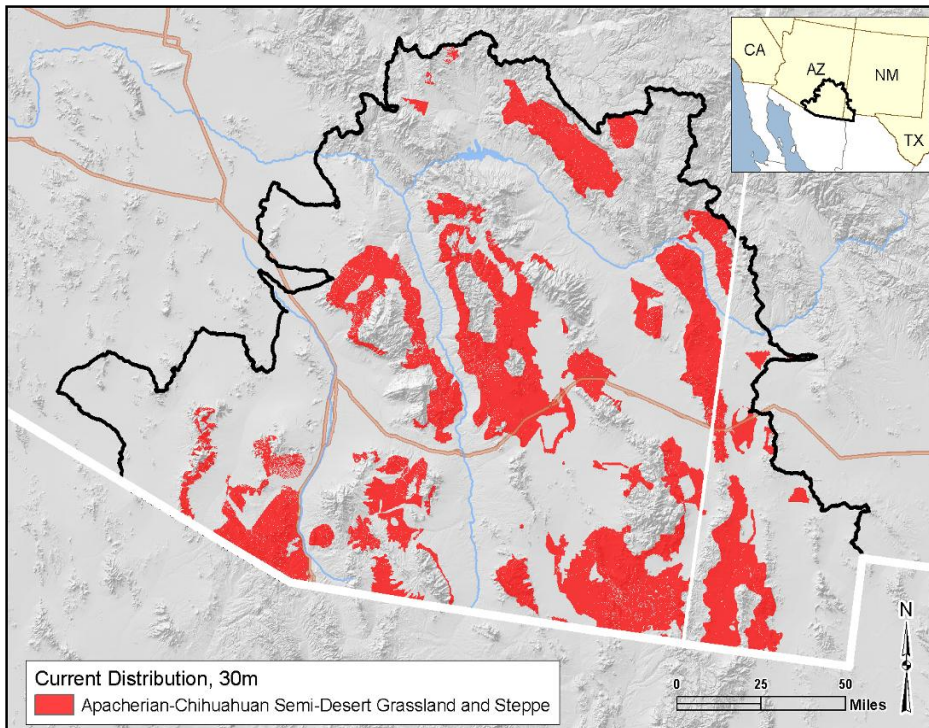
## Change Agents

This grassland ecological system can be directly affected by livestock grazing, direct and indirect fire suppression, land development, non-native plant species invasion, and increases in native shrub species. Grazing of native vegetation by livestock at incompatible stocking rates, season of use, or duration can be detrimental to grass vigor, resulting in decline of grass cover and shifts in species composition to more grazing tolerant or less palatable species. Over time this often results in increased woody cover or bare ground, and erosion and heavy grazing can indirectly decrease fire return intervals by removing fine fuels that carry fire. Fire suppression has led to an increase in the abundance of woody species and changes in woody species composition, resulting in an uncharacteristic fire regime in many stands. Invasive species have replaced native vegetation with non-native grass species such as Lehmann and Boer lovegrasses (*Eragrostis lehmanniana* and *Eragrostis curvula*). These species are better adapted to frequent fire and increase in relative abundance over native grasses after burning. Development impacts are common in this CE and contribute to altered fire regimes, increased erosion, direct habitat loss/conversion, increased groundwater pumping, fragmentation, invasive non-native species dispersal and disruption of wildlife migration patterns.



Apachean-Chihuahuan Semi-Desert Grassland and Steppe **Ecosystem** in Arizona. Photo from <http://azfirescape.org>.

## Current Distribution



The map at left shows the current distribution of Apachean-Chihuahuan Semi-Desert Grassland and Steppe within the MAR.

The distribution is mapped at a 30-meter resolution and was derived from the grassland mapping and assessment completed by The Nature Conservancy.

## Key Ecological Attributes

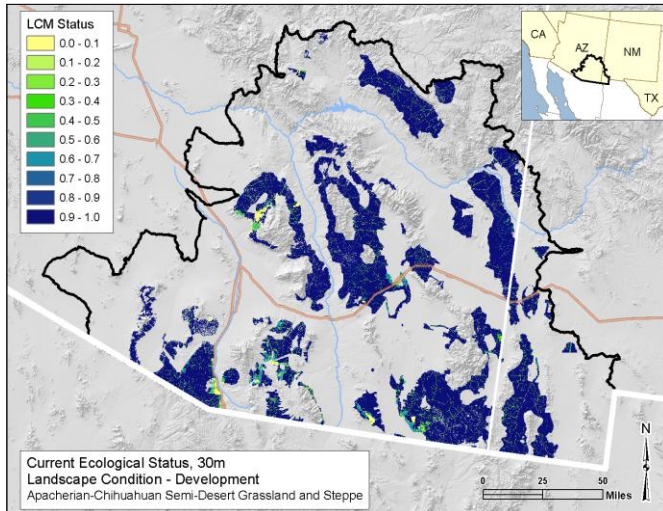
The following table provides an overview of the key ecological attributes (KEAs) that are critical for this grassland ecosystem, including indicators that can be used to assess the health of the attributes.

Key Ecological Attributes	Definition and Stressors	Indicators
<b>Landscape Context: Landscape Condition &amp; Cover</b>	Ecological conditions and landscape dynamics that support ecological systems are affected by fragmenting effects of land use. Land use impacts vary in their intensity where they occur, as well as their ecological effects with distance. Development infrastructure directly removes habitat and can degrade habitat through fragmentation, noise, and other impacts.	Development (e.g., roads, agriculture, urban development)
<b>Biotic Condition: Vegetation Composition</b>	The overall plant species composition and diversity of an ecosystem is an important aspect of its ecological integrity and largely defines it. These suites of species vary in their sensitivity to different stresses such as competition from invasive species. Alterations in the taxonomic, structural, and functional composition of the plant species assemblage beyond its natural ranges of variation therefore indicate the types and severities of stresses imposed on the ecosystem or on the animal species utilizing it for habitat.	Invasive Plant Species:  Abundance of non-native invasive species such as cheatgrass and buffelgrass  Abundance of native woody increaser (mesquite)
<b>Abiotic Condition: Fire Regime</b>	Fire is a natural agent of disturbance in vegetation communities in the Madrean Archipelago that maintains species composition, vegetation structure, and sustains ecological processes such as nutrient cycling. Fire can be removed (fire suppression) or can increase in frequency, leading to changes in fuel loads, changes in vegetation structure, and result in hotter, more destructive fires or loss of species not adapted to frequent fires.	Fire Regime Departure



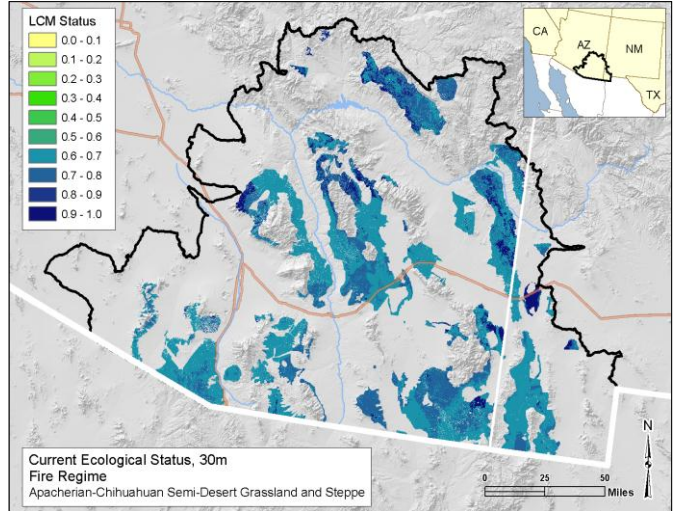
## Products and Key Findings: Ecological Status

The maps below show the current ecological status scores for the three indicators of development (top left), fire regime departure (top right), and invasive species (bottom). Each conservation element was assessed for current status or condition of its mapped distribution. LCM = landscape condition model. Yellow scores (equivalent to 0) indicate high impacts from the CAs and correspondingly lower ecological status; dark blue (equivalent to 1) indicate little to no impact from the CAs and correspondingly higher ecological status.



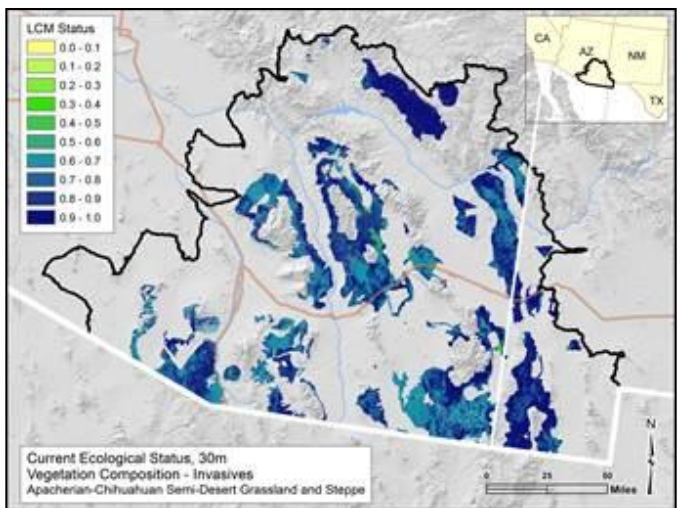
The development indicator (above) shows several large areas and corridors of intense municipal and agricultural development. Development impacts are especially noticeable in and around Portal, Douglas, Bisbee, Sonoita, Patagonia, Nogales, Tucson, Willcox, Fort Huachuca, Oro Valley, and Rio Rico, and along corridors associated with interstate highways 10 and 19, and other larger roads. At this scale the dispersed effects of smaller development features such as dirt roads, transmission corridors, pipelines, and cell towers are not noticeable, although they still have local impacts on the grasslands.

As illustrated in the second map (top right), much of this CE's extent shows moderate to severe departure from the natural fire regime. Areas with low departure tend to occur in smaller patches restricted to higher elevation grasslands. These results are consistent with research documenting the results of fire exclusion in the MAR ecoregion. Active and passive fire suppression over the last century has excluded fire from much of this ecological system, resulting in increased woody species cover and an uncharacteristic fire regime in many stands. This altered (uncharacteristic) fire regime greatly influences ecosystem processes,



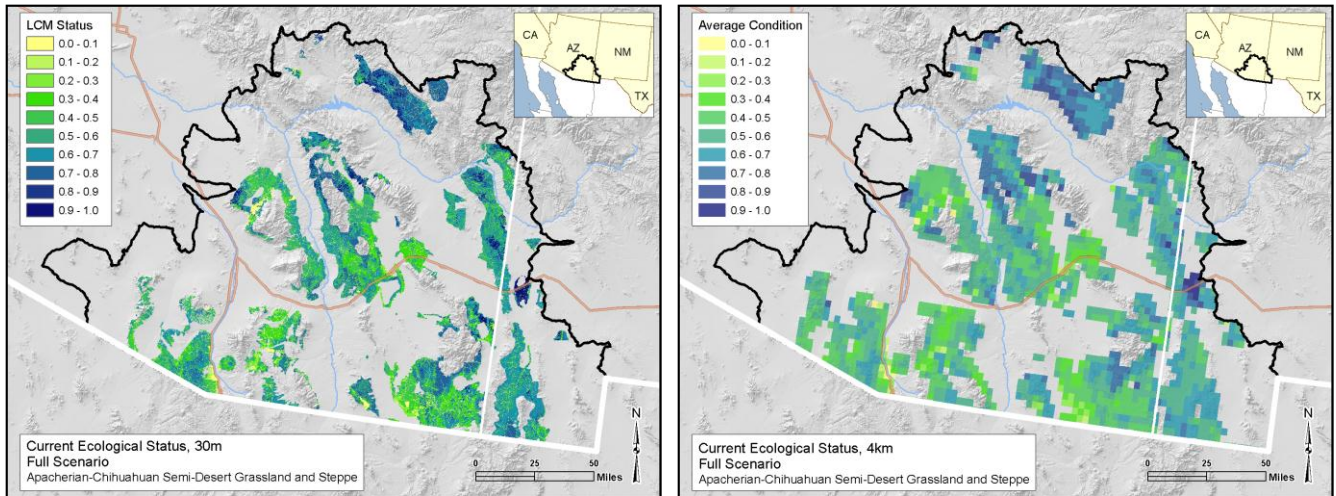
resulting in grasslands becoming dominated by woody vegetation and eventually converted to shrublands or woodlands.

The third map (above) indicates moderate (>10 -15%) to high (>25%) cover of invasive mesquite or exotic grasses and forbs. There are significant areas with low or no cover of invasive species in small patches often at higher elevations, and in large patches in Natanes Plateau and ranges in the boot heel of New Mexico. Area with high cover of both non-native grasses and forbs and invasive mesquite are indicated in light green patches east of the Galliluro Mountains.



## Products and Key Findings: Ecological Status

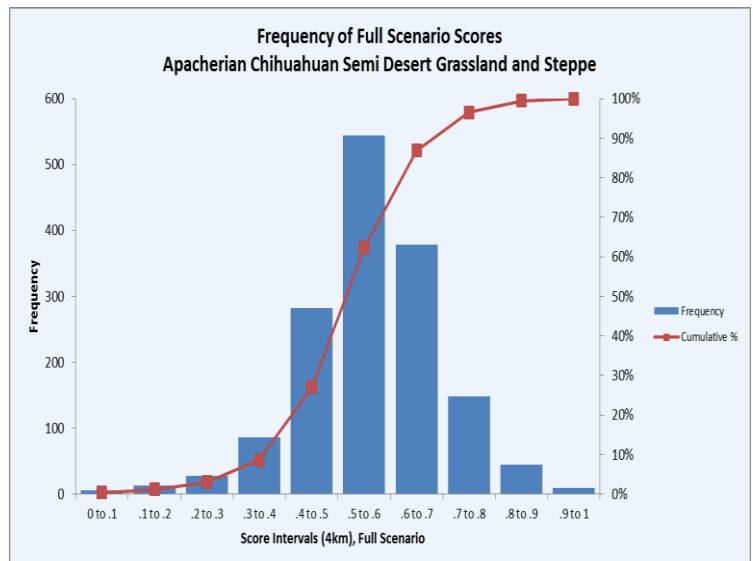
The three indicators of development, fire regime departure and invasive species, were also combined for the Apacherian-Chihuahuan Semi-Desert Grassland and Steppe CE into one overall ecological status score. The 30 m pixel results (left) were then averaged to produce a status score per “reporting unit” (4x4 km grids, right).



The graph (below) indicates the frequency distribution of ecological status scores for the CE. The x-axis represents the 0.1 increment scoring intervals (where zero = low status and 1.0 good status); the y-axis shows the number of grid cells in each interval; and the cumulative percentage of the grid cells for each interval (red curve line). Most values (~70%) fall below 0.6 for overall ecological status, indicating that most of its distribution are of low to moderate status.

The results, shown in both the maps and the frequency diagram, indicate the widespread general degradation of the Apacherian-Chihuahuan Semi-Desert Grassland and Steppe CE across its range in the ecoregion. There are a few local areas of better ecological condition, a result of low level of development, low or no cover of invasive species, and moderate fire regime departure primarily in the northern and eastern portions of its distribution.

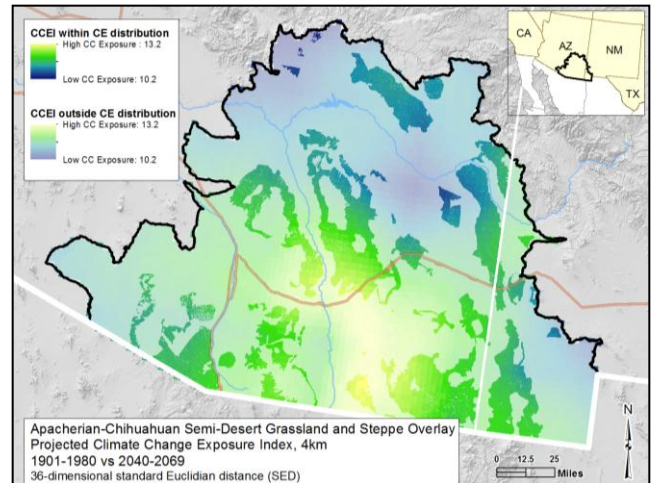
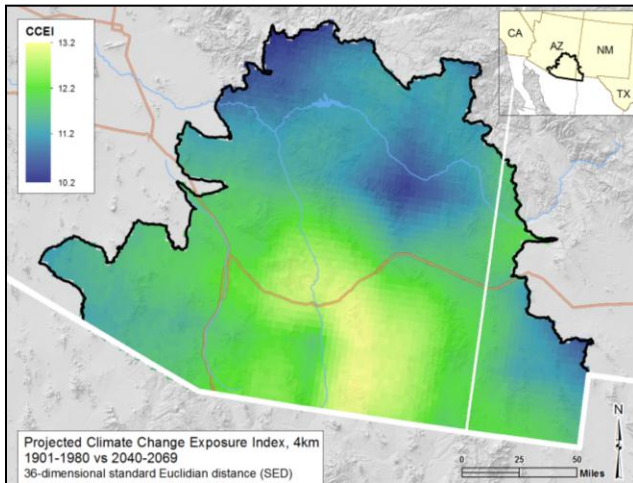
The Apacherian-Chihuahuan Semi-Desert Grassland and Steppe is greatly affected by both altered fire regime and invasives, with development also common in lower elevation stands. With fire exclusion, these grasslands are vulnerable to increases in native shrub cover, especially invasive mesquite and juniper. Also, the introduction of two invasive, non-native perennial grasses, Lehmann and Boer lovegrasses (*Eragrostis lehmanniana* and *Eragrostis curvula*) has impacted many locations. These species were frequently planted in the past to re-vegetate depleted ranges. The impacts from development are typically more severe and permanent than altered fire regime and invasives.





## Products and Key Findings: Climate Change

The climate change assessments compared differences in temperature and precipitation between two time periods: recent (1981-2012) vs. baseline (1901-1980), and future (2040-2069) vs. baseline. These differences are expressed in actual units of climate (degrees Celsius or mm of precipitation) as well as in relation to historical variability (units of standard deviation from the baseline mean). For recent trends only, additional analysis explores statistically significant trends within the recent period (as opposed to comparing it to a baseline climate). Assessment of CE climate stress (right) and bioclimate envelopes (bottom figure) were also conducted.



In this map (left), only the upper values of the projected climate change exposure index are displayed. All values shown represent significant change in climate; displaying only the values of the scale range that are present allows visualization of the different values for projected climate exposure across the ecoregion. The distribution of the Apacherian-Chihuahuan Semi-desert Grassland and Steppe was overlaid on the climate change exposure index (right, indicated by the darker shaded overlay areas).

The bioclimatic envelope of the Apacherian-Chihuahuan grassland community is currently widely distributed across the southern and eastern MAR, but is projected to contract significantly by mid-century both within the MAR and throughout the entire distribution. Large regions of projected expansion also exist, but these fall almost entirely outside the MAR boundary. Of the four CE bioclimates modeled, the Apacherian-Chihuahuan grassland was projected to have the largest area of contraction as a percentage of its total current distribution, with relatively little overlap between modeled current and future distributions.

The map at right shows a summary of modeled expansion (blue in map), contraction (yellow), and stability (green) for the geographic distribution of suitable climate conditions for Apacherian-Chihuahuan Semi-desert Grassland and Steppe.

Contraction areas are where suitable climate for the conservation element currently exists but may not in the future, overlap is where current and future climate are suitable, and expansion is where current climate is not suitable but may be in the future.

